DOCUMENT RESUME

ED 200 955 CS 006 054

TITLE	Strategies for Improving Reading Skills in Science.
INSTITUTION	Texas Education Agency, Austin. Div. of Curriculum Development.
PUB DATE	81
NOTE	41p.
AVAILABLE FROM	Publications Distribution Office, Texas Education Agency, Division of Curriculum Development, 201 East 11th St., Austin, TX 78701 (First copy free, additional copies $1.00).
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Classroom Techniques; *Content Area Reading; Elementary Secondary Education; Informal Reading Inventories; *Questioning Techniques; Reading Comprehension; Reading Instruction; *Reading Skills; *Science Instruction; *Study Skills; Test Wiseness
IDENTIFIERS	Note Taking

ABSTRACT

Designed particularly with secondary school teachers in mind but applicable to elementary school teachers as well, this publication summarizes research and suggests activities for improving student reading skills in the content area of science. Sections of the publication provide the following information: (1) how to determine student reading levels with informal reading inventories, cloze procedures, and the San Diego Quick Assessment; (2) ways of estimating the reading levels of instructional materials; (3) tips on improving student reading skills, such as vocabulary and comprehension/thinking skills; (4) tips on effective note taking; (5) strategies for test taking, including general rules and techniques applicable to objective and essay tests; and (6) questioning techniques that teachers can use to improve student comprehension. The publication also contains a list of common science reading problems, with proposed remedies. An appendix contains general and specific suggestions for science teachers' increased involvement in the total reading program. (RL)

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Strategies for Improving Reading Skills In Science

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Foreword

Many educators accept the fact that reading instruction and learning to read are sequential and developmental life-long processes, extending from kindergarten through adult life with gradual refinement of skills. Educational leaders now realize that direct teaching of reading skills and application of these skills must proceed in an unbroken line from Grade 1 through 12 in every subject in which reading is a significant means of obtaining information. The schools can no longer assume that by the time the student reaches Grade 6 he or she will have developed all the skills needed to deal with complex reading materials. Secondary schools present highly specialized content areas, and the instructional reading material is placed at grade level; however, reading skill instruction does not adequately prepare all students to read and comprehend specialized vocabulary at grade level.

In the past, many science teachers perceived themselves as being untrained for a role in reading instruction. They felt reading was the domain of the reading specialist, and they were unprepared and hesitant to accept that responsibility. This concept is gradually changing. For students to succeed in academic content courses such as science, content teachers and administrators, as well as reading specialists, must accept responsibility for the development of reading competencies.

Alton O. Bowen
Commissioner of Education

Acknowledgments

Appreciation is extended to the following educators for donating their time to reviewing drafts and to making suggestions for the improvement of this publication.

Rolland Bartholomew	Associate Professor of Secondary Science The University of Texas at Austin
Max Bolen	Coordinator of Science Education The University of Texas at El Paso
Richard Clevenger	Associate Professor of Chemistry East Texas State University
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Introduction

The student's ability to read a wide variety of printed material is basic to the acquisition of virtually all knowledge and skills. Although today's students acquire much of their information through such mass media as television, film, and radio, printed material still represents one of the most important sources of knowledge and is probably the most commonly used tool of the teacher. A wealth of information is derived from books, magazines, newspapers, documents, pamphlets, and other printed materials. Students must apply a great number of reading skills to acquire the data necessary to develop meaningful concepts and generalizations from these materials.

The study of science demands certain reading skills that are necessary for effective general reading in any subject area. In addition, science has its own vocabulary and places special demands on the reading ability of the student. Each teacher faces the challenge of helping students deal with the problems encountered in reading, especially in reading textbooks. The teacher, therefore, should:

- determine the reading level of each student
- determine by readability formula the reading levels of textbooks and other printed materials
- match reading materials to student reading levels
- enhance learning by utilizing teaching strategies designed to improve student reading skills
- keep informed of current teaching practices

Although most science teachers are highly knowledgeable in their content area, many recognize their lack of experience in integrating reading instruction with the subject matter. This publication provides direction to help teachers enhance their teaching effectiveness as they seek to improve students' reading skills in science.

Designed particularly with secondary teachers in mind, the publication can also be of value to elementary teachers and teacher education students. Not intended as a definitive study of reading, it summarizes research for the busy teacher who wants to increase knowledge and improve skills but who has limited time to review the literature relative to teaching reading skills.

Determining Student Reading Levels

Within a typical classroom, the teacher will generally encounter a wide range of reading abilities. For example, there may be as much as a seven-year spread in reading achievement between the best and the poorest readers in a Grade 8 class. Research also reveals that this range increases as students move into high school.

Although most science teachers, particularly secondary teachers, are usually not trained in the teaching of reading, they may contribute to the improvement of the student's ability to read science materials in a number of ways. One of the most important ways is by matching the appropriate materials to the reading ability of each student.

To achieve this purpose, the teacher must begin with a knowledge of the following four reading levels:

- *independent* reading level, highest level at which the student reads comfortably without assistance
- *instructional* level, at which the student makes satisfactory progress under teacher guidance
- *frustration* level, at which the student no longer functions adequately with the materials, even with assistance
- *potential* level, the highest level at which the student can understand material that is read to him or her

Student scores on standardized reading/listening tests may be available to the teacher and are useful in comparing students' reading achievement with national norms. They are generally of little use, however, in determining the independent, instructional, frustration, or potential reading level of a particular student. The teacher may use any of several informal procedures to estimate these reading levels. The following procedure is one of the most practical ones suitable for teachers who have not received training in the teaching of reading.

Informal Reading Inventory

An informal reading inventory may be constructed and administered to determine the students' various levels of reading performance. For example: to construct an informal reading inventory for a Grade 8 student, these steps should be accomplished:

Selections from materials that provide a range of readability levels should be obtained. For testing an eighth grader, materials of a readability range from about Grade 3 through Grade 12 levels should be chosen. The Fry readability formula (or other, if preferred) should be used to determine the level of the materials.

A representative passage of about 250-300 words should be selected from the materials in each readability level. A short group of comprehension and/or vocabulary questions (based on the content) should be formulated for each passage selected.

Start the student with a selection at least two grade levels below his or her suspected reading level. The student reads the passages orally to you. Then the comprehension/vocabulary test should be given. If the student is unable to successfully read or comprehend a particular passage, he or she should be moved back two levels. The teacher continues to give the student progressively more difficult material to read and comprehension/vocabulary questions to be answered until the levels of performance are determined.

A student who is reading on the independent level can recognize 99 percent of all the words read orally in the selection and can score at least 90 percent on the comprehension questions. At the instructional level, the student must achieve a minimum word recognition score of 95 percent and a comprehension rating of 75 percent or better. The frustration level is reached when the student recognizes less than 95 percent of the words read orally and scores below 75 percent on the comprehension section. The value of the oral reading test for students reading above the Grade 7 level is widely questioned by reading specialists. Therefore, it is recommended that a silent reading test be given to most secondary students. The silent test can be administered to the entire class at the same time. If the silent test is used, comprehension is tested but not word recognition. For each graded selection, the teacher prepares a written test that covers comprehension and vocabulary. The same rating scale is used.

CLOZE Procedure

One of the easiest and most successful procedures used by teachers to determine student reading levels is the CLOZE procedure.* The CLOZE procedure is based upon passages, representative of various levels of reading difficulty, that students have not previously encountered. Each passage should contain between 250-300 words and should be representative of the material. A passage that is relatively loaded with names, dates, and numerical data should not be chosen. In counting words in the selected passage, proper nouns and dates should not be counted or used as a blank. Beginning with the second sentence in each passage, every fifth word is deleted and replaced with blanks. All blanks should be of equal length. This should result in 50 deletions.

Administration

The CLOZE procedure can be easily administered by following directions:

1. Students are not to use their textbooks in completing the CLOZE exercise.

2. Before passing out the exercise, inform students that they will be taking a test that will attempt to measure the difficulty of their class reading materials. Show them how CLOZE works with examples such as, "It's dark in here. Please turn on the_____." Tell the students to try reading the passage through before beginning to fill in the blanks.

3. Allow students enough time to complete the exercise. Each passage is typed on a separate sheet. A selected passage would look something like the portion of a sample on page 3.

*John Bormuth, "The CLOZE Readability Procedure," Elementary English Vol. XLV (April 1968): 429-436.

You know, of course, that a great ocean of water covers more than 70 percent of the earth's surface. You are about to _____(1) a study of another _____(2) ocean—the atmosphere. The _____(3) is sometimes referred to _____(4) the ocean of air _____(5) completely envelops the earth. _____(6) us, who live at _____(7) bottom of this ocean, _____(8) atmosphere is vitally important. _____(9) the day, the atmosphere _____(10) us from much of _____(11) radiation emitted by the _____(12). At night, the atmosphere _____(13) as a blanket, holding _____(14) some of the heat _____(15) the earth absorbed from _____(16) sun during the day. _____(17) an earth without an _____(18), the change in temperature _____(19) day to night would _____(20) unbearable. What is the _____(21) made of? Is it _____(22) same everywhere about the _____(23)? Why does the atmosphere _____(24) as it does? As _____(25) study Chapter 18, you _____(26) discover the answers to _____(27) questions. You will also _____(28) that many factors interact _____(29) produce the weather on _____(30) earth's surface. The weather, _____(31) course, nothing more _____(32) the condition of the _____(33) atmosphere at a particular _____(34) and at a particular _____(35). Naturally, you will not _____(36) an expert meteorologist through _____(37) experiences in studying this _____(38) chapter. Hopefully, however, you _____(39) discover some of the _____(40) processes that produce the _____(41) and other atmospheric conditions. _____(42) you may decide to _____(43) your study of the _____(44) and work toward a _____(45) in some aspect of the _____(46).

The atmosphere, as you _____(47), is the layer of _____(48) that surrounds the earth. _____(49) gas is, in reality, _____(50) mixture of gases and is usually called air.

Answers to the CLOZE Procedure

1	begin	26	will
2	great	27	these
3	atmosphere	28	discover
4	as	29	to
5	that	30	our
6	To	31	of
7	the	32	than
8	the	33	earth's
9	During	34	place
10	shields	35	time
11	the	36	become
12	sun	37	your
13	acts	38	one
14	in	39	will
15	that	40	fundamental
16	the	41	winds
17	On	42	Perhaps
18	atmosphere	43	continue
19	from	44	atmosphere
20	be	45	career
21	atmosphere	46	meteorology
22	the	47	know
23	earth	48	gas
24	move	49	This
25	you	50	a

Scoring

- Score only the exact words as correct. Misspelled words are not considered errors.
- Figure the score in terms of 100 percent. Since there are 50 blanks, each response equals two percentage points. There is no time limit.

Evaluation and Interpretation

Evaluation of the CLOZE procedure is based on the number of correctly completed CLOZE units. This is used to assign levels of reading comprehension. There are three such levels:

- The Frustration Level at which the student experiences confusion and tension in the reading situation; a frustration level is indicated if the student scores 43 percent or below on the CLOZE procedure.
- The Instructional Level is that level at which the student is able to read with a minimum of instruction. A score of 44-57 percent is indicative of this level.
- The third level is the Independent Level. At this level the CLOZE score should be above 57 percent.

Each student should continue the testing process until enough data have been collected to determine these three levels of reading.

In addition to a knowledge of the student's reading levels, the teacher must also have some idea of the readability of textbooks and other reading materials that are available. There are a number of readability formulas that may be used by the teacher to estimate the relative difficuly of these materials. One of the more widely used formulas, the Fry Readability Formula, is discussed on pages 7-8.

San Diego Quick Assessment

A screening device designed to give the teacher an estimate of the student's level of reading was developed by Margaret LaPray, professor of education, San Diego State University. This assessment gives indicators of the:

- reading vocabularly level
- errors in word analysis
- errors in pronunciation

To administer this instrument:

- Type or print the list of 10 San Diego Quick Assessment words for a grade on an index card.
- Begin assessing a student by having the student quickly pronounce the words on a card. Start with a list of words at least two years below his or her expected level. If the student makes any errors, drop back to easier grades until no errors are made.
- Write down incorrect responses.
- Scoring
  - One error indicates the independent reading level.
  - Two errors indicate the student's instructional reading level.

NOTE: Sometimes a student may miss only one word in two or three consecutive lists. The correct procedure is to continue the test until the student misses two words.

Usually the instructional level is one or more years above the one determined to be the independent reading level. Generally, one grade above the instructional reading level is the frustration level, and one above the frustration level is the student's potential level.

Excerpted from the
San Diego State College—Quick Assessment*

The following is an oral screening device for use in classrooms and clinics. It is often given to determine where to begin in an informal reading inventory. A skilled clinician can, in a matter of three minutes, ascertain a reading level and gain some knowledge of the student's word attack skills.

Each list of 10 words should be typed on an index card so that the student doesn't ever see more than 10 words at a time. Write in the words that the student substitutes or misses.

Grade 3	Grade 4	Grade 5	Grade 6	Grade 7
city _____	decided _____	scanty _____	bridge _____	amber _____
middle _____	served _____	business _____	commercial _____	dominion _____
moment _____	amazed _____	develop _____	abolish _____	sundry _____
frightened _____	silent _____	considered _____	trucker _____	capillary _____
exclaimed _____	wrecked _____	discussed _____	apparatus _____	impetuous _____
several _____	improved _____	behaved _____	elementary _____	blight _____
lonely _____	certainly _____	splendid _____	comment _____	wrest _____
drew _____	entered _____	acquainted _____	necessity _____	enumerate _____
since _____	realized _____	escaped _____	gallery _____	daunted _____

Grade 8	Grade 9	Grade 10	Grade 11
capacious _____	conscientious _____	zany _____	galore _____
limitation _____	isolation _____	jerkin _____	rotunda _____
pretext _____	molecule _____	nausea _____	capitalism _____
intrigue _____	ritual _____	gratuitous _____	prevaricate _____
delusion _____	momentous _____	linear _____	risible _____
immaculate _____	vulnerable _____	inept _____	exonerate _____
ascent _____	kinship _____	legality _____	superannuate _____
acrid _____	conservatism _____	aspen _____	luxuriate _____
binocular _____	jaunty _____	amnesty _____	piebald _____
embankment _____	inventive _____	barometer _____	crunch _____

The preceding oral screening device is for placement purposes, if a student misses more than two words in any one list, drop back a level.

*Margaret LaPray, *Teaching Children to Become Independent Readers* (New York: The Center for Applied Research in Education).

Estimating the Reading Level Of Instructional Materials

Although readability usually varies a great deal within a book or other printed materials, it is possible to arrive at a reasonably accurate estimate of the general reading level of the material by applying a readability formula. These formulae are based on such factors as:

- number of unfamiliar words
- average sentence length
- average number of syllables in the words
- average number of clauses and phrases in the sentence

There are several reliable readability formulas of which the Fry Readability Formula is an example.

The Fry Formula was prepared in 1965 by Dr. Edward Fry (currently director of the Reading Center of Rutgers University, New Brunswick, New Jersey). The Formula has been under revision, the latest revision being approved in 1976.

The Fry Formula is frequently used because of its simplicity and reliability. The procedure for applying the Formula to a book or a reading selection includes the steps listed below.

Expanded Directions for Working Readability Graph

1. Randomly select three sample passages and count out exactly 100 words starting with the beginning of a sentence. Do count proper nouns, initializations, and numerals.

2. Count the number of sentences in the 100 words estimating the length of the fraction of the last sentence to the nearest 1/10th.

3. Count the total number of syllables in the 100-word passage. If you don't have a hand counter available, simply put a mark above every syllable over one in each word, then when you get to the end of the passage, count the number of marks and add 100. Small calculators can also be used as counters by pushing, for each word or syllable when counting, numeral "1" then the "+" sign.

4. Enter graph with *average* sentence length and *average* number of syllables; plot dot where the two lines intersect. Area where dot is plotted will give you the approximate grade level. (See example, page 8.)

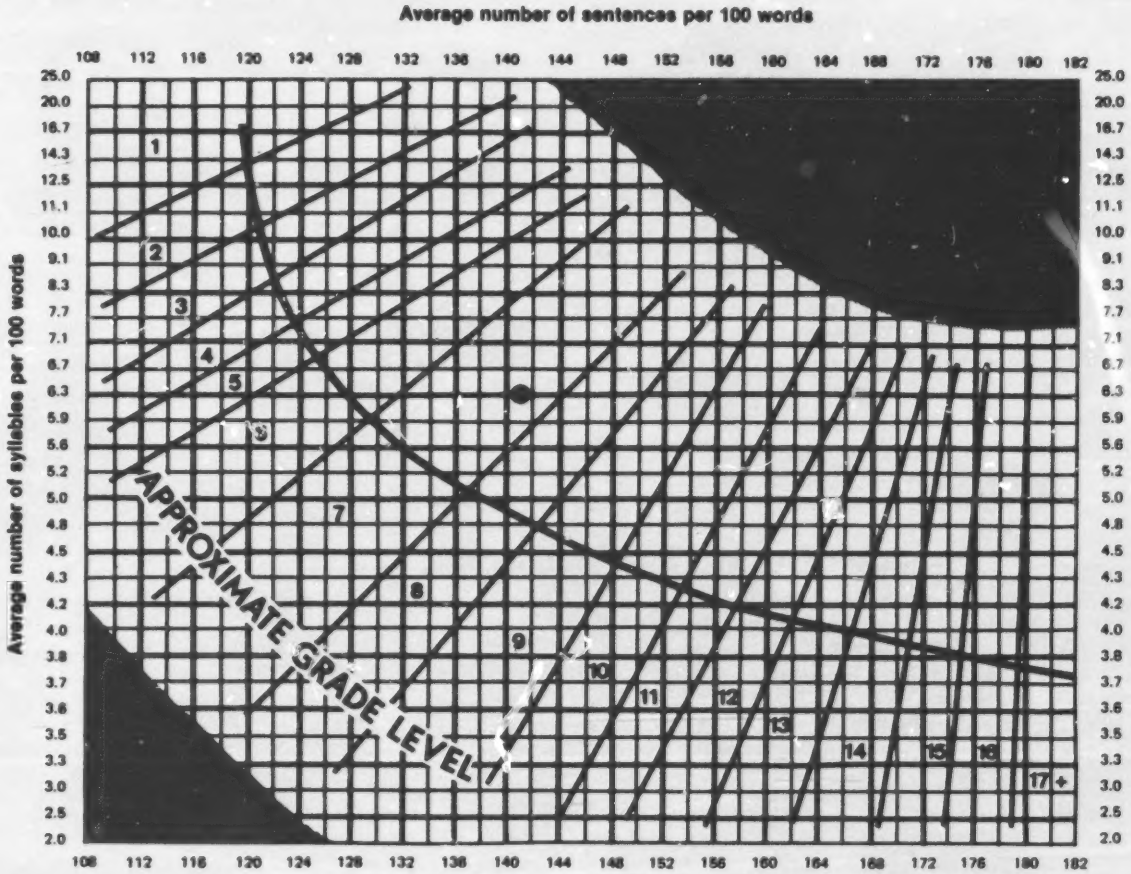
5. If a great deal of variability is found in syllable count or sentence count, putting more samples into the average is desirable.

6. A word is defined as a group of symbols with a space on either side; thus, "Joe," "IRA," "1945," and "&" are each one word.

7. A syllable is defined as a phonetic syllable. Generally, there are as many syllables as vowel sounds. For example, "stopped" is one syllable and "wanted" is two syllables. When counting syllables for numerals and initializations, count one syllable for each symbol. For example, "1945" is four syllables, "IRA" is three syllables, and "&" is one syllable.

Graph for Estimating Readability—Extended

by Edward Fry, Rutgers University Reading Center, New Brunswick, N.J. 08904



Improving Student Reading Skills

Research has led many educators to conclude that success in general reading ability is no guarantee of success with the various types of reading materials used in the content areas. Results from several studies indicate that, although general reading ability and the ability to read in various subject areas have much in common, certain reading skills are especially significant to reading success in each of the content areas.

The teacher can be instrumental in improving student reading ability by providing guidance and experiences designed to develop and improve those skills that are most significant to success in reading science materials. These generally fall into two major categories: Vocabulary Skills and Comprehension or Thinking Skills.

Vocabulary Skills

Vocabulary competence is generally accepted as being paramount to the mastery of content in a subject. The specialized and technical words of science are labels for concepts the student must understand in order to achieve success in communicating ideas pertinent to science and in thinking abstractly about them.

According to reading authority Lou E. Burmeister in *Reading Strategies for Secondary Teachers,* the teacher can have considerable impact on the student's vocabulary development. The teacher can provide guidance and experiences in the following areas:

- the learning of common words that take on specialized meaning in the context of science reading materials *(culture, normal, fault, resistance)*
- the learning of new words that are unique to science *(photosynthesis, friction, multicellular, fulcrum)*
- the learning and understanding of how new words common to science enter our language through coining or borrowing from other languages *(television, astronaut, transistor, induced, sputnik)*
- the awareness and understanding of how words over time can change in meaning

Because vocabulary power is such an extremely important facet of reading power, instructional time should be consistently devoted to the development of the specialized vocabulary for each of the content areas. Suggestions for vocabulary development in the science classroom vary from source to source. However, some of the more frequent suggestions follow.

Teach Words In Context

As unfamiliar words are introduced, they should be taught in the context of the passage that is to be assigned. Much confusion and many misinterpretations result when students are sent to the dictionary with a list of words in isolation. In addition, knowledge of the various types of context clues can be a tremendous help to students as they try to unlock the meaning of a word.

Although there are as many as 10 or more types of context clues, generally four types are used:

- Definition or explanation clues—an outright explanation or definition of a word's meaning given to assist the reader
  EXAMPLE: *Culture*—to develop or grow micro-organisms in an artificial medium.
- Example clue—an example given near the word to help illuminate the meaning
  EXAMPLE: *Sedimentary rocks,* such as limestone, sandstone, and shale, were deposited in layers.

- Restatement of meaning clue—the meaning related in other words
  EXAMPLE: *Villi (tiny, fingerlike projections)* cover the folds lining the small intestine and give it a velvety appearance.

- Comparison or contrast clue—the new word compared or contrasted with another idea
  EXAMPLE: Much of the land on the plateau is too *arid* for farming, but the river supplies adequate water in the valley for crops.

Use Concrete Examples

New words have much more meaning for students when concrete examples and first-hand experiences are used to illustrate them. Pictures, objects, dramatizations, models, and audiovisual aids should be used whenever possible. A field trip can give much more meaning to the word *moss* than looking the word up in a dictionary. Likewise, the word *granite* has more meaning for the student who has the opportunity to examine a sample of the rock. Opportunities should also be provided for students to relate a new word to their own experiences and to give illustrations of the word from these experiences.

Examine Words for Meaningful Parts

After taking a quick glance at a long word such as *microscope* that looks unfamiliar, some readers will skip over the word. The teacher can help such students by making them aware that long words have parts and that often prefixes and suffixes can be removed until a recognizable root word—in this case, *scope*—appears. Every time students are provided the opportunity to analyze parts of different words, they build a working knowledge of prefixes, suffixes, and root words. When students have a working knowledge of common Greek and Latin word parts and learn to use them in combination with context clues, they greatly expand the potential of their vocabulary power.

Work Out Forbidding-Looking Words

The teacher can help students attack unknown polysyllabic words by encouraging them to break the words down into syllables. Students should learn that every syllable contains a vowel sound and that the number of syllables in a word is determined by the number of vowel sounds.

Comprehension—Thinking Skills

Reading success involves much more than recognizing the meaning of individual words and pronouncing them correctly. It requires students to think and to use their imaginations. Reading authorities differ in their opinions of the essential comprehension or thinking skills needed for effectively reading science materials. However, some of the basic skills on which there is general agreement are:

- following directions
- recalling facts
- recognizing and recalling main ideas
- perceiving unstated relationships
- obtaining information from graphic sources
- making comparisons and contrasts
- drawing inferences

- recognizing a situation in which a previously learned principle applies and utilizing the principle successfully

- making generalizations

Giving Directions

The extent to which some students achieve success in comprehending a reading assignment may depend upon how well the teacher has given directions for the reading assignment. This area is one of the many in which the science teacher can contribute to reading success without specialized training in reading. A competency measure on following directions is given in the Appendix.

There are a number of models or guidelines for making reading assignments. The SQ3R, described below, is one such model.

SQ3R*

A technique, developed by reading specialist Francis P. Robinson in 1961, is frequently used for directing subject-matter reading. This method, called SQ3R, gives greater retention of information in the material read.

S, for *Surveying*—The reader is to make an overview of the material to be read by noting a number of things that the material may contain, namely:

- Chapter title(s)
- Chapter section heading
- Specific quotes
- Boldface printing
- Special words
- Italicized terms or phrases
- Aids such as pictures, graphs, charts, tables,
- diagrams, maps

Q, for *Questioning*—Keeping the assignment in mind, the reader now formulates questions that he or she believes the material to be read can help answer. A concentrated effort is made to set up questions that are directly related to the assignment being pursued. One helpful procedure is for the reader to transform the chapter subheadings into questions.

R, for *Reading*—The student will now read the material, noting the parts of the material that appear to be most appropriate to the specific assignment. The reader needs to answer the questions formed from chapter subheadings in step "Q." Some parts will be read initially with more care than other parts, for the reader realizes the material is more pertinent to the assignment. The rate of reading will vary as the difficulty and the need for the information the materials contains varies.

R, for *Recite*—Students are encouraged to think about the information they have found as they relate it to the questions previously formulated. The reader should attempt to answer the questions (from step "Q") without referring to the text. Through this process, the reader can sense areas that need more thorough treatment, perhaps, rereading.

R, for *Review*—The reflection process will tend to point up areas covered in the material read initially that need further treatment. This material may be reread with a concentrated effort to "dig" for the information it contains that is relevant to the specific assignment. This *Review* is done in two phases.

- upon completion of the reading assignment

- when preparing for class discussion or a test

*Arnold Burron, and Amos Claybaugh, *Using Reading to Teach Subject Matter.* (Columbus, Ohio: Charles E. Merrill Books, Inc., 1975.)

Reading Laboratory Procedures

One way a teacher can help students learn to read laboratory procedures is to instruct them to take the following steps:

- Read the title. It usually gives clues to the type of activity that will be done.
- Read the introduction. This portion gives an overview of the activity. It may present critical information and/or a safety note. While reading the introduction, ask yourself, "How does this activity relate to what I have studied?"
- "Preread" the entire procedure and discussion questions. "Once over lightly" is the scheme to get in mind the answer to the question: "In general, what am I to do?"
- Read the procedure for detail. This time you should stop for reflection at the end of each sentence. Get firmly in mind what to do and the sequence. Time for thought is needed in addition to reading time.
- As you read the procedures, there may be references to diagrams. Many of these diagrams may be easy to grasp, but some have details that are elusive. When referred to a diagram, shift your attention to the diagram. Read the caption, then examine the diagram carefully. Note details and labels with their corresponding parts. Then shift back to the reading of the procedure.
- Reread the procedure as many times as necessary until you have in mind what you are to do.

Providing Alternative Instructional Materials

When the text being used is beyond the reading ability of a student, the teacher should seek alternative ways of aiding the student to learn the science content.

- Other sources of material (pamphlets, other textbooks, magazine articles) covering the same topics might be used.
- Use of a project or team approach allows the central task to be subdivided into subtasks, each of which can be assigned to different members of the investigating committee. With committee members using a wide variety of materials in their search for information (not all of which may involve reading), the committee approach reduces the stigma often attached to low-level reading groups. Each subtask is analyzed by committee members with the aid of the teacher and is organized into an outline of procedures for pursuing investigation.
- In certain situations, the teacher may wish to rewrite existing material so that the students can better comprehend it.

Rewriting Existing Material

The following tips have been found to help in rewriting instructional materials:

- Get the idea clearly in your mind, then write.
- Make every word count.
- Use words that are familiar to the reader.

- Stress communication rather than literary style.
- Make positive statements.
- Use short, concise sentences.
- Present the facts.
- Stress nouns and verbs rather than modifiers and qualifiers.
- Use graphics when possible.
- Edit and proofread your work.

Test the rewritten material with the students, and let them discuss your effort.

Study Aids for Science

Some students tend to view maps, charts, graphs, and pictures as fillers they may skip to shorten a reading assignment. Unfortunately, these students fail to perceive that these are aids the author uses to provide additional information or to illustrate a concept so that it will be easier for the reader to understand.

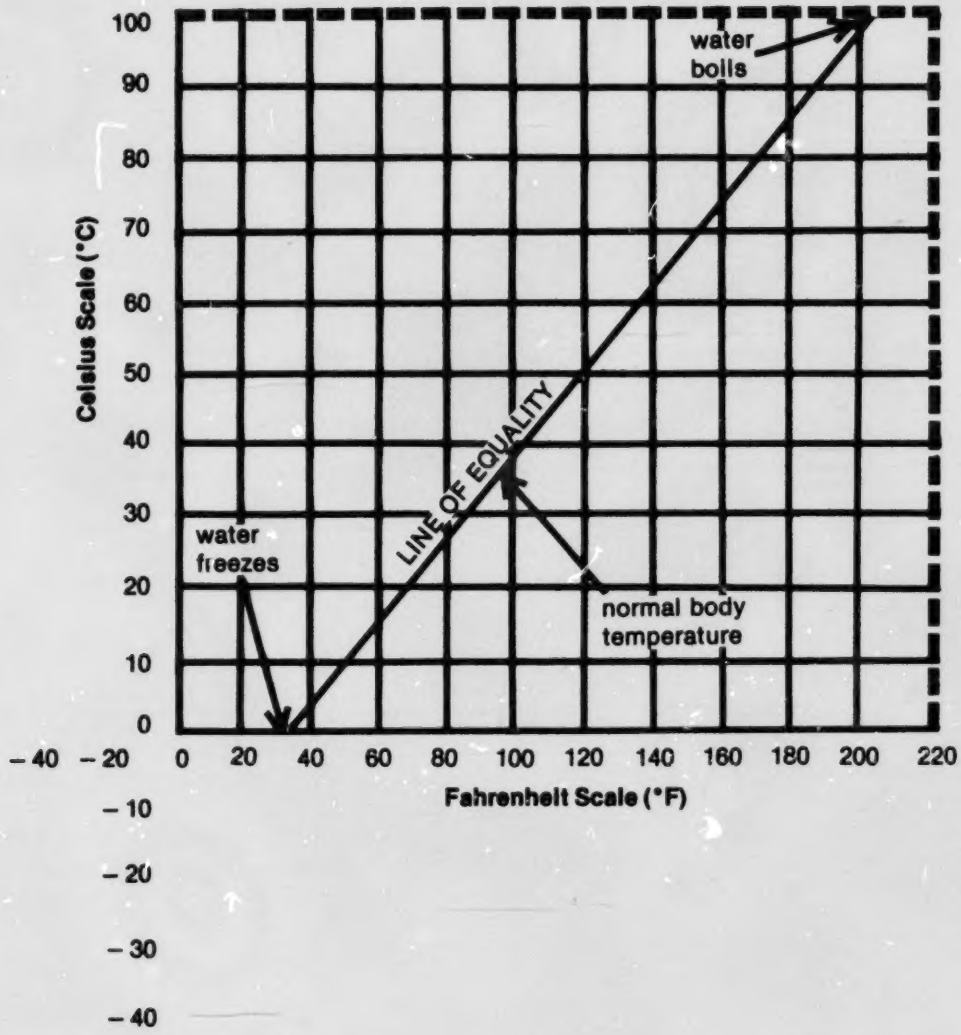
Successful use of graphic aids is especially significant to the comprehension of the variety of reading materials in the science classoom. To use graphic aids successfully, the student must understand what is stated directly in the graphic aid and what is implied. The reader must first determine what information the graphic aid conveys. Then he or she must seek deeper meaning through inferences, generalizations, and conclusions, drawing upon the data presented and his or her own experiential background.

The teacher can assist students by:

- calling attention to the importance of graphic aids through various teaching strategies that require the student to use the aids
- giving specific instructions on how to use various types of graphic aids
- structuring various levels of questions relative to information presented in the aids

Science teachers may wish to develop lessons, exercises, and drills on the use of graphics especially designed in their classes.

Example of Using a Graph



Circle the letter that indicates the answer to the following questions. Use the graph to obtain the needed information.

1. Each line on the Fahrenheit scale stands for how many degrees?

   (a) 1 (b) 5 (c) 10 (d) 20

2. If the outside temperature one day was 25 °C, would you say it was

   (a) below freezing (b) cold (c) comfortable (d) hot

3. If the normal body temperature is 98.6 °F, what is it in degrees Celsius?

   (a) 37 (b) 22 (c) 56 (d) 98.6

4. At 0 °F, what is the Celsius reading?

   (a) 17.8 (b) 40 (c) – 17.8 (d) – 40

Note Making*

Most students find that effective note making depends on mastery of a difficult set of skills. Note making requires concentrated attention, skillful reading and/or listening, and putting into practice the ability to organize thoughts into a logical pattern.

Teachers can aid students in learning how to take notes by:

- Reproducing and distributing a set of detailed notes for a lesson. Then the lecture or lesson can be presented with specific comments about the notes and how ideas were developed in the lesson. (This step may need to be repeated for some classes.)

- Presenting (on the chalkboard or overhead projector) an abbreviated set of notes on a lesson. Comments might be made as to how the abbreviated notes could be expanded into a more fully developed, complete set of notes.

- Presenting a lesson while students take notes. The teacher should review each student's notes with the student to indicate:

  - where abbreviations might have been used to shorten the notes
  - points that had been omitted
  - points that could have been omitted while retaining the message intended

Good note making whether while reading or listening requires the student to learn to write and to pay attention at the same time. Assimilation and learning should be taking place. Comprehension is the prime consideration. The student should learn to listen and read for meaning rather than for mere words.

Teachers can encourage the student to focus on the main idea and on those points that support the main idea. The student's notes should be a clue to the organization of the original material.

Basic Forms of Note Making

- *Paragraph*—This form is probably most easily developed, but it frequently is not the best organized. Each paragraph represents a new idea.

- *Sentences*—This is better than the paragraph form in that it attempts to organize the material by staging a series of sentences. It thus may also be easier to use in review.

- *Outline*—This form provides the best opportunity for organization.

Guidelines for Effective Note Making

- Use a standard 8½" by 11" notebook.

- Use a looseleaf notebook, not clipboards, small pads, or ordinary writing tablets.

*Materials on pages 15-17 were adapted from *Reading in the Content Areas*, a workshop packet developed by Ann Neely of Austin Independent School District and published by Region XIII Education Service Center.

- Divide paper into two sections: the right side of the page for actual note making, the left margin for personal comments. Below the notes and personal comments may be written the summary.
- Number each page, entitle notes, and begin each new topic on a new page.
- Keep notes from different classes in separate notebooks, or separate them with dividers or tabs.
- Take notes in ink.
- Use only one side of the page.
- Make notes brief and to the point.
- Use quotation marks whenever the writer's or the speaker's words are quoted.
- Copy definitions, formulas, and statistics exactly. They usually cannot be shortened.
- Move on if a point is missed. Allow room to add it later.
- Combine notes on the same topic.
- Make notes of those items that are emphasized, that are frequently repeated, on which there will be an examination, and that are written on the chalkboard.
- Make a table of contents for the notebook.
- Organize notes, indicating supporting point and subtopics.
- Read or listen to a complete segment before beginning to write notes.
- Formulate the main idea as concisely as possible.
- List all important facts beneath the main idea in as short a form as possible.
- Look for organizational aids such as *first, second,* or points, or introductions and summaries.
- Know how to use outline form for note making.

Styles of Note Making

- Take notes in brief form, grammatically incorrect and abbreviated.
- Take notes in outline form—formal or informal.
- Take notes in sentence form.
- Take notes in fact-inference charts.
- Note origin of information for footnotes and bibliography.

How to Teach Good Note Making

Good note taking is a twin to good listening. One rarely exists without the other. To help students learn to take notes well, the following tips may be given, followed by the suggested practice.

Student Tip: Make fewer notes. Use more *think*—less ink. Write down the main ideas.

Practice (To the Teacher): Give your students a specific note-taking assignment: Listen to a certain radio talk, a speaker in the school assembly, or a lecture session of your own. Show them a sample of good, succinct note taking. Have student turn in their notes. Show less skillful note takers how they could improve their note taking and perhaps shorten the notes, yet maintain the same amount of information.

Student Tip: Develop a *notehand,* a personal shorthand to speed up note taking.

Practice (To the Teacher): Get students started by writing some possible abbreviations on the board. Help them figure out which words are used most often. Then give them an assignment which uses their own personal notehand.

Student Tip: Mark items the teacher stresses.

Practice (To the Teacher): If students will place stars in their notebooks beside the information you've said is most important, it will help them in reviewing for exams. After note-taking sessions, ask, "What did you 'star' today?" This will help them to remember to use this valuable technique.

Test Taking Techniques*

Knowing how to write or respond to questions in an examination is just as important as knowing how to study for it. A student may know the material yet get a failing mark because he or she lacks the basic skills involved in actually taking an examination. Probably the best way a teacher can help students learn how to take examinations is to give them a practice exam in the classroom and to watch carefully how each student approaches it. Before the practice begins, students should be given the following pointers.

General Information for the Student

- Give yourself the advantage of a good start; be certain of the time, place, and materials required for the exam; arrive with enough time to arrange your working conditions and build a calm, alert attitude. Avoid getting involved in a last-minute cram session with panicky classmates.
- Read the directions preceding the exam very closely.
- Read the entire set of examination questions before writing down a word.
- First answer the easy questions, the ones you are most sure of.
- Spend more time on questions that give the most points; much time can be wasted on answering questions that add little to the final score.
- Do not allow lapses of memory to produce anxiety or fear; such lapses are normal.
- Do not waste time with emotional reactions to the quiz questions.
- Be sure to double check all the answers before turning in the examination paper; chances are you'll find several errors that would have lowered your mark.

Objective Tests

- Read directions carefully; listen for oral directions or corrections.
- Glance quickly through the test to plan your time and to see if your test form is complete and correctly collated.
- Do what you *know* first; there may be clues within the test to the difficult questions.
- Accept the questions at face value; don't read anything in or out.
- Watch carefully the meaning of questions containing double negatives.
- Give full attention to each question in turn; don't worry about one question while trying to answer another.
- Try to supply your own answer before reading the choices that are provided.
- Guess, unless there's a severe penalty.

*Adapted from Doris Wilcox Gilbert, *Study in Depth* (Englewood Cliffs, N.J.: Prentice-Hall, 1966), p.48.

Essay Tests

General Directions

- Read all essay questions before starting to write; if any ideas come to you, jot them down on scratch paper.
- Make sure you understand what you have been asked to do; e.g., explain, justify, define, compare.
- Think before writing; make notes.
- Start with what you know; this reduces anxiety and facilitates clearer thinking.
- If the question seems ambiguous, vague, or too broad, make clear your interpretation before answering.
- Provide specific as well as general information; use the technical vocabulary of the course.
- Always write something; leave space at the end for additions to your answers.
- Write legibly.
- Check to see that your answers are clearly identified with the proper question.
- Proofread; even a few moments spent in correcting grammar, punctuation, and spelling may improve your grade.

Key Word in Essay Questions

1. *Enumerate* — Name one after another; list in concise form.

   Enumerate the ways of generating electricity.

2. *Evaluate* — Give the good points and the bad ones: appraise; give an opinion regarding the value of it; talk over the advantages and limitations.

   Evaluate the contributions of Aristotle to physics.

3. *Contrast* — Bring out the points of difference.

   Contrast the methods of studying science used by Aristotle and Galileo.

4. *Explain* — Make clear; interpret; make plain; tell how to do; tell the meaning of.

   Explain how leaves change from green to brown.

5. *Describe* — Give an account of; tell about; give a word picture of.

   Describe the formation of a fossil.

6. *Define* — Give the meaning of a word or concept; place it in the class to which it belongs and set it off from other items in the same class.

   Define the term isotherm.

7. *Compare*	Bring out points of similarity and points of difference.
	Compare the jet engine with the rocket engine.
8. *Discuss*	Talk over; consider from various points of view, present the different sides of.
	Discuss the use of pesticides in controlling insects.
9. *Criticize*	State your opinion of the correctness or merits of an item or issue; criticism may approve or disapprove.
	Criticize the increasing use of petroleum.
10. *Justify*	Show good reasons for; give your evidence; present facts to support your position.
	Justify the use of herbicides in agriculture.
11. *Trace*	Follow the course of; follow the trail of; give a description of progress.
	Trace the development of the triode.
12. *Interpret*	Make plain; give the meaning of; give your thinking about; translate.
	Interpret the equation $F = ma$.
13. *Prove*	Establish the truth of something by giving factual evidence or logical reasons.
	Prove that water is a compound.
14. *Illustrate*	Use a word picture, a diagram, a chart, or a concrete example to clarify a point.
	Illustrate the water cycle.
15. *Summarize*	Sum up; give the main points briefly.
	Summarize the ways in which people preserve food.

Questioning Strategies

Another way the teacher can contribute to the development of comprehension or thinking skills is by carefully choosing the type of questions used relative to a reading assignment. Many educators conclude that students will develop higher levels of thinking skills if given experience in answering various types of questions involving the various cognitive levels.

With this idea in mind, several teachers under the leadership of Norris M. Sanders, an authority on questioning strategies, developed a taxonomy of questions based upon noted educator Benjamin S. Bloom's *Taxonomy of Educational Objectives.* The results of this work were published by Harper and Row in 1966 in a book entitled *Classroom Questions: What Kinds?* Listed below are definitions of the seven levels of questions identified by Sanders and his colleagues. These can be used as a guide for developing questions that call for the various levels of thinking.

Levels of Questioning

Memory Level

Questions require the student to recall or recognize information accumulated from past experiences.

Examples:

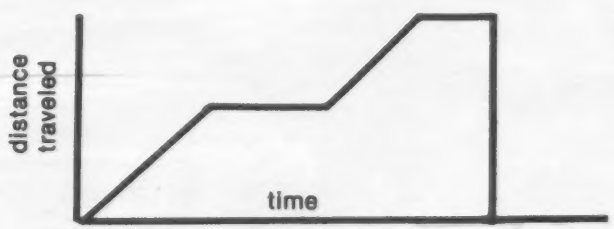
- In what phylum should the housefly be classified?
- What is the chemical formula for water?
- What is the S.I. unit for the measurement of mass?
- What class of rocks is referred to as "fire made"?

Translation Level

Questions require the student to change information into a different symbolic form or language. They describe an idea and instruct the student to express the idea in a different form of communication with substantially the same meaning. Common types of questions at the translation level relate to changing information from one verbal form to another and from a verbal form to a pictorial or graphic form, matching paraphrased descriptions, and sociodramas.

Examples:

- The class reads material that contains an illustration of the nitrogen cycle. Students are instructed to write a paragraph explaining the nitrogen cycle.
- The class studies a passage containing an illustration of the apparatus used in the electrolysis of water. Students are asked to discuss the process of electrolysis.
- The class is given material containing a line graph depicting distance traveled versus time. The members of the class are asked to discuss the motion of the object.



- Students read a passage that contains an illustration of the rock cycle. The class is asked to discuss how one type of rock is changed into another type.

Interpretation Level

Questions require the student to perceive relationships among given parts of a communication (facts, generalizations, definitions, values, or skills). The student makes use of the *inductive leap* to see the relationship that exists. Various formats for interpretation questions are: like or different, degree of similarity, comparison of specific points, analogies, irrelevant item, and scrambled outline.

Examples:

- Students have studied the characteristics of the plant phyla. Plants are distributed to the students, and they are asked to classify each in its proper phylum.

- A class has studied the conditions that allow a chemical reaction to occur. Students are given a set of chemical equations and are asked to predict which reactions will occur.

- Students have studied the behavior of electricity in circuits. They are asked to write a paragraph explaining how the light system of a car operates.

- Students have studied the Mohs scale of hardness of minerals. They are asked which of the following minerals would be suitable as an abrasive for grinding:

  a) gypsum c) talc
  b) corundum d) fluorite

Application Level

This level of questioning is similar to the interpretation level in that, in both, students are asked to use previously acquired knowledge in situations that are new to the students. The application step takes the process one step further by not telling the student what previously acquired fact to use in solving the problem. This level of questioning requires the student to transfer the knowledge into new situations. Students must select and apply appropriate facts, values, generalizations, and skills to solve the new problem.

Examples:

- After studying tropisms, the biology students observe an experiment on plants. The plants had been started in flower pots, allowed to grow normally for three weeks, then the pots were laid on their sides. The plants curved. The students were asked to discuss the causes of the bending of the plants.

- After being taught how to use the index and table of contents of their textbooks, chemistry students were asked, "What elements were discovered by the Curies?"

- At the conclusion of a unit on sound, physics students were asked to design and build a xylophone.

- As a concluding activity on stratigraphy, geology students were asked to map and propose a geologic history of the rock layers found in a road cut.

Analysis Level

Questions require students to solve problems with an awareness of the thinking processes they are using. The student should identify the parts, and the relationships among the parts, of a communication to realize that the rules of reasoning apply to the relationships identified. Also.

the student should determine consciously whether the relationships satisfy the appropriate rules of reasoning.

Analysis questions are always preceded by instruction in some logical process. Some of the most useful logical processes are classification, induction, deduction, cause and effect, informal fallacies, semantic problems, operational definitions, and psychological obstacles to thinking.

Examples:

- Students have been studying the scientific method including the controlling of all variables and of identifying variables that are likely to make a difference. During a session involving the question, "What do plants need to make food and to grow?", the following account was read to them:

  > During the early 1800s, the Dutch physician Jean van Helmont did an experiment to find what a plant needed to grow. His procedure was to fill an earthenware pot with 200 pounds of sterilized soil, which he then soaked with rainwater. A five-pound willow shoot was placed in the soil. After five years of giving the willow only rainwater, he dried the soil and willow tree. There had been no change in the weight of the soil but the tree now weighed 100 pounds. From this evidence, van Helmont concluded that only water was involved in the growth of a tree.

  From the procedure and the data obtained, students are asked if they would have arrived at the same conclusion? Why or why not?

  Comments on the question: On the basis of the account and on their knowledge of constituents in soil and air, the students are asked to determine the types of variables that must be accounted for and whether or not the conditions necessary for arriving at such a conclusion have been met.

- Chemistry students have studied the nature of induction and deduction. They already have had a course in biology in which characteristics of enzymes have been presented. The generalization that an increase of 10 °C results in a doubling of the speed of a chemical reaction was given in the biology course. The chemistry teacher, in drawing an example from another field, gives an example using an enzyme. "At 10 °C, four milligrams per hour is produced; at 30 °C, 16 milligrams is produced." Mary observes, "Just think, at 100 °C we could produce more than two grams per minute."

  Is Mary justified in making such a statement? Why or why not?

  Comment on the question: To answer, students will have to determine whether induction or deduction can be applied to this situation and then find out to what degree the conditions for these have been met.

- A ninth grade student is using the Celsius thermometer for the first time. The operational definitions have been explained. The student is given a thermometer calibrated in degrees Celsius, a hot plate, source of water, beaker, and ice. The student is asked to perform an experiment and to make an operational definition for a Celsius degree on the basis of the data obtained. The student keeps a log of temperature from the time the ice begins melting until the water is boiling. The operational definition is as follows: "A degree Celsius is the temperature that raises the mercury level 1/100 of the distance between what it is when the thermometer is placed in ice water and when the thermometer is placed in boiling water."

  On the basis of what has been given about the procedure, would students agree with the operational definition as proposed? Why or why not?

Synthesis Level

Questions require the student to combine parts of his or her past experience to create an original product (a unique communication, a plan, or a relationship). Great freedom is given students in deciding what is to be created and how it is to be created. A synthesis question never has only one correct response. There are always many good answers that students may work out.

Examples:

- Biology students have been discussing interaction and interdependence. Included in the discussion were parasitic and symbiotic relationships of animals. The students were given information on the screw fly, which included the estimated number, conditions needed for survival, and amount of damage attributed to them in the southern U.S. each year. The students know reproduction methods, and they know characteristics are transmitted. They develop a program that could be carried out in an effort to reduce, or eliminate entirely, the screw fly problem.

Comment on the question: There is freedom in choosing what to try, such as extermination or getting rid of breeding places. Students can decide what to do.

- Chemistry students have a knowledge of chemical equations and of energy and randomness requirements for a reaction to occur. They know how to determine the types of products given off and their characteristics. They also have a knowledge of a number of methods that could be used in purification of a substance. As an end-of-year project, they are given the following task: Develop a procedure for producing AgCl which is 99 percent pure, and carry it out.

- Physics students have been studying heat energy, heats of fusion, and heats of solution. They are acquainted with calories and calorimeters. They also are able to obtain and use reliable data from normal laboratory equipment such as a thermometer and a balance. Students design and carry out an experiment that will allow them to determine the heat of a solution of a salt (NaCl) in an alcohol (CH_3OH).

Comments on the question: There is freedom in the response in terms of such variables as type of calorimeter, type of thermometer used, period of time involved, and concentrations of solutions.

- While on a field trip, earth science students discovered an outcrop of limestone that contains fossils. Upon testing the limestone, they find that the fossils are silica. They devise a plan to extract and clean the fossils from the matrix. They perform the activity.

Evaluation Level

This level of questioning requires the student to make a value judgment of a situation, process, or product. The student must establish appropriate standards to support judgment. As part of the answer, the student gives the judgment and tells the considerations that led him or her to make it.

Examples:

- Biology students have studied interrelationships and interdependence. Included was a discussion of the food chain. The question of controlling and eliminating certain undesirable animals is discussed, using the following situation:

  Farmer Brown has appeared before the County Board to request a bounty be placed on foxes in the county. He has lost a number of chickens, and evidence collected indicates that a fox was responsible. If a bounty is placed on the foxes, someone will kill them, and Brown will be able to raise chickens again in peace.

If the students were members of the County Board, would they vote for or against such a bounty and why?

- Chemistry students have been given information about two methods of producing nitrogen gas. One industrial plant is 50 percent complete and relatively cheap but gives off a large amount of SO_2 gas. The other is 25 percent complete, is expensive, but yields very little SO_2 gas. The other wastes are nonharmful. Which one of these methods would students vote to use if they had their choice? Why?

- Students in a Physics Science Study Committee (PSSC) class have been discussing the uncertainty of data and the various types of errors that might be involved. The physics students are requested to turn in all data during an experiment. Peter's group does three trials, and the numbers vary. His group compares the data with that collected by Delores' group. Is Peter's group justified in reporting only the two values that corresponded closely to Delores' data so that the class average can be similar to the handbook value? Why or why not?

- In an advanced earth science problems class, students have been discussing the effects of radiation on the mutations of the fruit fly. They have a previous knowledge of the effects and tolerable limits of radiation on various kinds of marine life. They have a physics background and know about heat and currents that result from it. The following is given to them to evaluate:

  Scientists are turning to the sea in an effort to solve the food shortage problem of the future. Some scientists state it may even be necessary to farm the bottoms of the seas. Several scientists have gone so far as to ask for permission to dump atomic wastes, sealed in lead containers, into the ocean depths in an effort to stir up the ocean and warm the bottom so faster plant growth may result. Would the students allow the dumping of atomic wastes in this manner if they were members of the Atomic Energy Commission? Why or why not?

There are some qualifications that teachers should keep in mind as they apply this taxonomy to the development of questioning strategies.

- The term *question* is used broadly and may include a student activity as well as interrogative statements.

- The classification of a question is dependent on the teaching that has preceded it. What might be an evaluation-level question in one class could be a memory-level question in another if instruction related to the question has preceded it.

- In progressing to each succeeding classification, there will be elements of the preceding types of thinking required. For instance, translation requires memory; interpretation requires translation and memory. In practice, a question may be classified at the highest level on the taxonomy for which it qualifies.

Action Verbs

The following action verbs can be used to indicate the level of the question if instruction related to the question has not preceded it:

Memory-level verbs

define	list	recall
describe	match	recite
identify	name	select
label	outline	state

Translation-level verbs

convert	estimate	give examples
defend	explain	infer
distinguish	extend	summarize
	generalize	predict

Interpretation-level verbs

compare	paraphrase
contrast	translate
relate	transfer
discriminate	show similarities

Application-level verbs

change	employ	prepare
compute	modify	produce
demonstrate	operate	use
develop	organize	solve

Analysis-level verbs

break down	distinguish	outline
deduce	illustrate	point out
diagram	infer	relate
differentiate		separate
		subdivide

Synthesis-level verbs

categorize	create	formulate
couple	design	rewrite
compose	devise	summarize

Evaluation-level verbs

appraise	defend	support
conclude	justify	validate
criticize	interpret	

Reading Problems

The following includes reading problems commonly found by science teachers and proposed remedies and activities teachers can use to address the problems:

- *Problem:* Students have a limited reading and writing vocabulary.

  Proposed remedies:

  - Introduce and explain new terms. Use examples, concrete terms, and illustrations when possible.
  - Have students keep word files.
  - Use terms repeatedly.
  - See Vocabulary Skills, pages 9-10, for additional suggestions.

  Activity: Pick five terms from text to emphasize. Help students with pronunciation and meaning of these terms.

- *Problem:* Students cannot understand questions.

  Proposed remedies:

  - Give examples.
  - Rewrite/reword questions.
  - Reduce the number of questions.
  - See Questioning Strategies, pages 21-26.

  Activity: Rewrite two questions into simpler form (i.e., evaluation and synthesis level questions can be reworded to be analysis and interpretation level questions).

- *Problem:* Students cannot paraphrase material.

  Proposed remedy:

  - Have students put the lesson into their own words—repeatedly.

  Activity: Select sections of the text for students to read. Then, students tell or write about what they have read.

- *Problem:* Students cannot obtain information from tables, charts, and graphs.

  Proposed remedies:

  - Use large table, chart, or graph (or a transparency) to aid in teaching
    - what information is desired
    - where the data is located
    - the units of measurement used

- See Study Aids for Science, page 13, for example of using graphics.

Activity: Project a data table, chart, or graph and ask students to locate specific information.

- *Problem:* Students have difficulties in using the index, glossary, and appendix of textbook.

Proposed Remedy:

- Conduct supervised activity of how and where to find information in the textbook.

Activity: Make a list of three items of information that the students will be able to find. One item should be from each section: glossary, index, and appendix.

Appendix

The Science Teacher's Role in the Total Reading Program

GENERAL SUGGESTIONS	SPECIFIC SUGGESTIONS
Every Teacher Can:	**The Science Teacher Can:**
Create more enthusiasm for reading assignments.	
• Give previews of the assignment to capture interest. Teachers should never say, "Read the next chapter for tomorrow."	• Conduct prelab discussions in which key concepts and purposes are identified.
• Relate the assignment to the students' personal experiences.	• Demonstrate scientific principles that are described in the assignment.
• Give students purposes for reading; then help them accomplish their purposes.	• Offer anecdotes about scientists who are named in the assignment.
• Provide stimulating study guides when appropriate.	
Teach vocabulary expansion	
• Preteach *stopper* words.	• Identify mathematics and science symbols to be used throughout the assignment.
• Emphasize content analysis as the most important vocabulary tool.	• Point out root words, suffixes, and prefixes in naming families of compounds.
• Teach structural analysis (Latin and Greek roots), especially prefixes and suffixes common to the subject.	
• Spotlight an easy root word within a long, forbidding word.	
• Teach word origins to add excitement to vocabulary study.	
• Encourage wide reading, including magazines and newspapers.	
Show students how to read their textbooks. This one skill, essential to success in every subject, is practically never taught directly.	
• At the beginning of a course, show students how the book is organized.	• Demonstrate the use of special appendices.
• Before ever assigning Chapter 1, point out aids to reading: center headings, side headings, italicized phrases, boldfaced topics.	• Make assignments according to the design of the text.
• Teach students to read maps, charts, graphs, and illustrations.	• Review techniques for reading the text.
• Walk students through a chapter or partial chapter to show them how to outline main points.	• Use practice sessions to aid students in developing specific skills.

Every Teacher Can:	The Science Teacher Can:
Teach students to identify the main ideas. Research indicates that even bright students have difficulty identifying main ideas. *(Harvard Education Review,* XXIX, Summer 1959.)	
• Teach students to see relationships between ideas as they read. • Show students the various places where main ideas may be located in paragraphs or in whole chapters. • Convince students of the essential relationship between the ability to locate main ideas and the ability to summarize, organize, and outline.	• Interrelate examples from other scientific disciplines to various fields of study. • Point out the location of main ideas in the texts that are often italicized or highlighted.
Strengthen reading comprehension through use of the inquiry method. Research indicates that reading comprehension is essentially the same as thinking. Critical thinking can be taught through purposeful questioning.	
• Use mostly oral questions. Group discussion triggers an ego involvement that stimulates students to formulate ideas and to locate information to defend their ideas. • Ask open-ended questions to emphasize the value of students' points of view.	• Prepare a laboratory exercise to demonstrate the principles to be studied and suggest their explanation. • Assign projects that require library research, manipulation of equipment, and extended time for completion.
Focus on memory retrieval.	
• Have students practice saying or writing what they have read. Focus on *output* as much as on *input.* • Teach students to *listen* to the text as a communication to them and to *answer* with ideas of their own.	• Assist students with short cuts to remember and offer clever alternatives to memorization. Example: Litmus Test R E ACID BASE L U E
Teach note making.	
• Train students to read with a pencil in hand. This makes study an active pursuit.	• Identify in writing the major topics for lecture, demonstrations, or audiovisual presentation.

Every Teacher Can:	The Science Teacher Can:
• Go through a section of the textbook with students and point out what kinds of information should be noted, i.e., information following such signal words as *first, most important, finally,* and *remember.* • Give students samples to illustrate how notes should be phrased in their own words.	• Offer summary statements or brief review questions at the conclusion of the lesson. • Highlight topics from previous lessons. • Prepare an abstract of the reading assignment. • Teach symbols and abbreviations used in science. • Encourage note taking at appropriate times.

Teach scanning and skimming.

• Inform students of the purposes of skimming (to get the general drift of a passage). Convince them that it is permissible to skip over some material at times. • Demonstrate how to skim a chapter in the textbook. • Inform students of the purposes of scanning (to locate specific information). Convince them that high speed scanning saves them time.	• Identify in writing the major topics for lecture, demonstration, and audiovisual presentation. • Offer summary statements or brief review questions at the conclusion of the lesson. • Highlight topics from previous lesson. • Prepare an abstract of the reading assignment. • Teach symbols and abbreviations in science. • Encourage note making at appropriate times.

Encourage study techniques. Convince students (especially college-bound students) of the efficiency and value of the SQ3R method (see page 11). Studies have shown that this method, which at first will seem to them like too much trouble, saves time and energy in the long run.

• Teach the students the SQ3R method (see page 11).	• Use the SQ3R method in class. • Teach toward a planned objective.

Make students aware of critical thinking operations. Formulate questions that are specifically designed to check students' comprehension on each level. Assignments should provoke thinking beyond the recall level, with both short-answer and discussion questions.

• Ask questions that require students to: *Recognize*—Put themselves in the setting and/or see the reality of the topic. *Recall*—Remember details or where to find them.	• Make homework assignments that are relevant and practical in terms of essential content and student time required. • Have students perform laboratory activities that reinforce lecture content.

Every Teacher Can:	The Science Teacher Can:
Analyze—Make inferences, determine main ideas. *Judge*—Select criteria for determining worth or value. *Use*—Extend the information to other situations.	• Follow-up on laboratory activities, media presentations, and assignments that were to be written and/or read. The teacher should use probing questions and encourage discussion.
Teach students to follow directions as given.	
• Teach students a listening technique and repeat directions only once. • Be sure students' attention is gained before giving directions. • Give simple, concise, and understandable directions in steps and wait for each step to be done before giving another. Later, the teacher can increase the number of steps given at a time.	• On the chalkboard, summarize the sequence of the laboratory instructions.
Motivate students who do not read in his or her class but who read in vocational classes.	
• Place emphasis on the reason for the reading, rather than on the reading itself. • Get students involved in "hands-on" projects for which reading instructions are a prerequisite. • Link reading assignments to concrete activities whenever possible.	• Inform students of high-interest reading materials in the library that are related to a topic or project. • Make use of offprints from various scientific periodicals.

To the Teacher: The following test may be distributed to students to determine how well they can follow directions.

Competency Measure for Following Directions

NAME _____

DATE _____

1. Read carefully all of the following directions before doing anything.
2. Print you name, last name first, on the top line following the word *name.*
3. Draw a circle around the word *all* in direction number 1.
4. Underline the word *name* in direction number 2.
5. In direction number 4, draw a circle around the word *underline,* and in sentence number 1, cross out the word *anything.*
6. Now, draw a circle around the title of this paper.
7. Circle the numbers of sentences 1, 2, 3, 4, and 5, and put an *X* over number 6.
8. In the sentence number 7, circle the even numbers, and underline the odd numbers. Put a circle around the number 4 in the fifth sentence.
9. Write *I can follow directions* above the title of this test. Start directly above the words, *Competency Measure.*
10. Underline the sentence you have just written.
11. Draw a square about ½-inch from the side of the upper left-hand corner of this paper. Draw a circle around the square.
12. Cross out the numbers *8 through 12* on the left column of these instructions. Now *circle* the same numbers.
13. Put an *X* in the square inside the circle in the upper left-hand corner.
14. In the space under the last direction on this paper, copy neatly, in writing, direction number 1.
15. Now that you have read all of the directions as stated in direction number one, follow direction number two only. Do not follow any of the other directions, omit them entirely. Please do not give away your elation at having followed the directions correctly by any comment or other outward behaviour (smiling, jumping up and down, etc.). Let's see how many of your colleagues follow directions correctly.

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, Department of Health, Education and Welfare.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964; EXECUTIVE ORDERS 11246 AND 11375; TITLE IX, 1973 EDUCATION AMENDMENTS; REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; AND VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulations by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs or activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.